**Evolution Critical Thinking Activity #1**

Pre-AP Biology, Mrs. Krouse

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**What are the learning objectives for this activity?**

Learning Objective #1: I can *analyze* data from a population of organisms to identify patterns.

Learning Objective #2: I can *apply* Darwin’s theory of natural selection to explain these patterns.

**What does it mean to analyze something?**

According to merriam-webster.com, to “analyze” is defined as “learning the nature and relationship of the parts of (something) by a close and careful examination.” Synonyms for “analyze” include examine, inspect, scrutinize, and dissect.

When teachers develop learning activities that include analysis, they may ask students to perform the following actions (among others): categorize, compare, contrast, interpret, predict, relate, and conclude.

Several learning activities are described below. For each activity, state whether you think this is an example of an analysis activity (yes or no). Explain your answer in the “Why or why not?” column. Then, after our class discussion, make necessary additions and revisions to your answer / explanation in the right column.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity Description** | **Is this an analysis activity? (Yes or No)** | **Why or Why Not?** | **Additions and Revisions After Class Discussion** |
| Students identify the capital cities in all 50 states of the US. |  |  |  |
| Students predict the migration timing of birds based on historical migration data and current weather reports. |  |  |  |
| Students make observations of an butterfly’s appearance throughout its life cycle. |  |  |  |
| Students compare the factors leading to several wars throughout history and try to identify common causes of war. |  |  |  |

**What does it mean to apply something?**

According to merriam-webster.com, to “apply” is defined as “to put to use especially for some practical purpose.” Synonyms for “apply” include implement, employ, relate to, and involve.

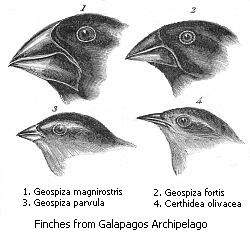
When teachers develop learning activities that include application, they may ask students to solve new problems using knowledge, facts, or skills that they have already learned. They may ask students to perform the following actions (among others): use, predict, explain, and solve.

*Note: There is some cross-over between analysis and application activities. In our activity today, we are going to analyze data and then explain this data by applying a concept we have learned in class (i.e. Darwin’s theory of natural selection).*

Several learning activities are described on the next page. For each activity, state whether you think this is an example of an application activity (yes or no). Explain your answer in the “Why or why not?” column. Then, after our class discussion, make necessary additions and revisions to your answer / explanation in the right column.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity Description** | **Is this an application activity? (Yes or No)** | **Why or Why Not?** | **Additions and Revisions After Class Discussion** |
| Students list the types of rocks and minerals. |  |  |  |
| Students use long division to solve a word problem in math class. |  |  |  |
| Students use their understanding of the characteristics of various types of animals (ex: fish, amphibians, reptiles, birds, and mammals) to identify a picture of an unknown animal. |  |  |  |
| Students explain to their friends how to set up a tent. |  |  |  |

**Now that we better understand what it means to analyze and apply, let’s try a sample application / analysis activity!**



1. The following chart summarizes data from three different islands in the Galapagos Island chain in South America regarding finch beak shape and size. There is actually quite a bit of variation across the islands with regard to finch beak shape and size (see image to the right.) (Note: Finches are little birds that Darwin observed / studied to help him develop his theory of natural selection.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Island** | **Number of Finches with large / wide** | **Number of finches with small / short beaks** | **Number of finches with narrow / long beaks** | **Total Number of Finches Observed** |
| Island A | 3 | 50 | 5 | 58 |
| Island B | 45 | 4 | 2 | 51 |
| Island C | 5 | 1 | 47 | 53 |

2) In the space below, identify the most frequent beak shape on each island and give a decimal frequency for this beak shape out of the total number of finches observed on the island.

Island A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Island B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Island C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3) Now, let’s say I told you that each island had the following food sources available.

Island A: Tiny seeds

Island B: Thick nuts

Island C: Insects that live in small holes in trees

4) In the chart below, for each island, explain how the island’s food source might have caused a particular beak shape to become more common through natural selection. Then, after the class discussion, make additions and revisions to your explanation.

|  |  |  |
| --- | --- | --- |
| **Island** | **Original Explanation** | **Additions and Revisions After Class Discussion** |
| Island A |  |  |
| Island B |  |  |
| Island C |  |  |

5) Now that we have completed the activity, let’s see if we can identify what the original learning objectives / goals for the activity were. To do so, please answer questions A-D given below individually. Then, we will discuss the answers to questions A-D as a class and together, we will answer question E.

1. Where in the activity did we analyze data?

B. What did we DO to analyze the data, and how did we describe our findings?

C. Where in the activity did we apply our understanding of Darwin’s theory of natural selection?

D. How did Darwin’s theory of natural selection help us to identify the relationship between finch beak shape and island food source?

E. Using the answers to the previous questions, let’s try to write two learning objectives for this sample activity as a class. One will focus on analysis and one will focus on application. We will use the same general format as the two learning objectives given at the very beginning of the document that apply to today’s critical thinking activity.

Learning Objective #1:

Learning Objective #2:

**Now that we have tried a sample activity as a class, please complete the following critical thinking activity in your assigned groups of 3-4 students.**

1. Remember, the learning objectives for this activity are as follows...

Learning Objective #1: I can *analyze* data from a population of organisms to identify patterns.

Learning Objective #2: I can *apply* Darwin’s theory of natural selection to explain these patterns.

2) Before we begin the activity, let’s summarize what we know so far about evolution and natural selection. Please define the terms evolution and natural selection below in your own words and explain the connection between the two concepts.

Evolution Definition:

Natural Selection Definition:

Connection between Evolution and Natural Selection:

3) Now, let’s get started! Here’s some information about the population of organisms we will be studying (courtesy of HHMI BioInteractive)

A typical rock pocket mouse is about 170 millimeters long from its nose to the end of its tail, shorter than an average pencil. And at just 15 grams, this tiny mouse weighs about as much as a handful of paper clips. Rock pocket mice, however, have had an enormous impact on science. What’s so special about them?

You can find populations of rock pocket mice all over the Sonoran Desert in the southwestern United States. There are two common varieties—a light-colored variety and a dark-colored variety. There are also two major colors of substrate, or surface materials, that make up the desert floor. Most of the landscape consists of light-colored sand and rock, but patches of dark volcanic rocks that formed from cooling lava flows are found, separated by several kilometers of light-colored substrate.

In this activity, we will be tracking the frequencies of light and dark-colored mice at two different locations--Location A and Location B over four points in time. We will use the pictures that follow to count the number of mice of each color. (Note: There are 12 mice in each picture.)

**Time #1:**



**Time #2:**



**Time #3:**



**Time #4:**



4) In the chart given below, record the number of light and dark-colored mice at each location at each point in time. Then, determine the decimal frequency of each color by dividing the number of mice of that particular color by the total number of mice at that location (i.e. 12).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Time 1** | **Time 2** | **Time 3** | **Time 4** |
| Location A | # of Light Mice |  |  |  |  |
| Dec. Freq. of Light Mice |  |  |  |  |
| # of Dark Mice |  |  |  |  |
| Dec. Freq. of Dark Mice |  |  |  |  |
| Location B | # of Light Mice |  |  |  |  |
| Dec. Freq. of Light Mice |  |  |  |  |
| # of Dark Mice |  |  |  |  |
| Dec. Freq. of Dark Mice |  |  |  |  |

5) Answer the follow-up questions given below about your data.

1. Describe what is happening with the decimal frequencies of light and dark mice over time at Location B. (Are they changing significantly or staying relatively the same?)
2. Describe what is happening with the environment (i.e. the substrate/sand color) at Location B. (Is it changing or staying the same?)
3. Describe what is happening with the decimal frequencies of light and dark mice over time at Location A. (Are they changing significantly or staying relatively the same?)
4. Describe what is happening with the environment (i.e. the substrate/sand color) at Location A. (Is it changing or staying the same?)

6) In the space below, write 1-2 paragraphs in which you explain how changes (or lack of change) in the color frequencies of mice at Locations A and B relate to changes (or lack of change) in the environment at Locations A and B. Make sure to use the terms “evolution” and “natural selection” in your response.

7) At this point, exchange your paper with another group. Read their response for #6 and provide them with verbal feedback. For example, you might remind them of required components they forgot to include (e.g., using the term “evolution” in their response) or indicate that they should clarify their wording in a particular sentence or phrase. You might also tell them if they have not established a direct connection between the environment and mouse color frequencies. You will receive this type of verbal feedback on your own response as well.

8) After discussing your response with the other group, identify any additions and revisions you would make to your response to #6 in the space below.

Additions:

Revisions:

9) Now, let’s see if we can reflect on the original learning objectives for this assignment….

A. In what part(s) of your original response or revised response to #6 did you show that you had mastered / accomplished Learning Objective #1 for this activity? (Identify specific sentences or phrases in your response.)

Learning Objective #1: I can *analyze* data from a population of organisms to identify patterns.

B. In what part(s) of your original response or revised response to #6 did you show that you had mastered / accomplished Learning Objective #2 for this activity? (Identify specific sentences or phrases in your response.)

Learning Objective #2: I can *apply* Darwin’s theory of natural selection to explain these patterns.